



# RECOMMISSIONING

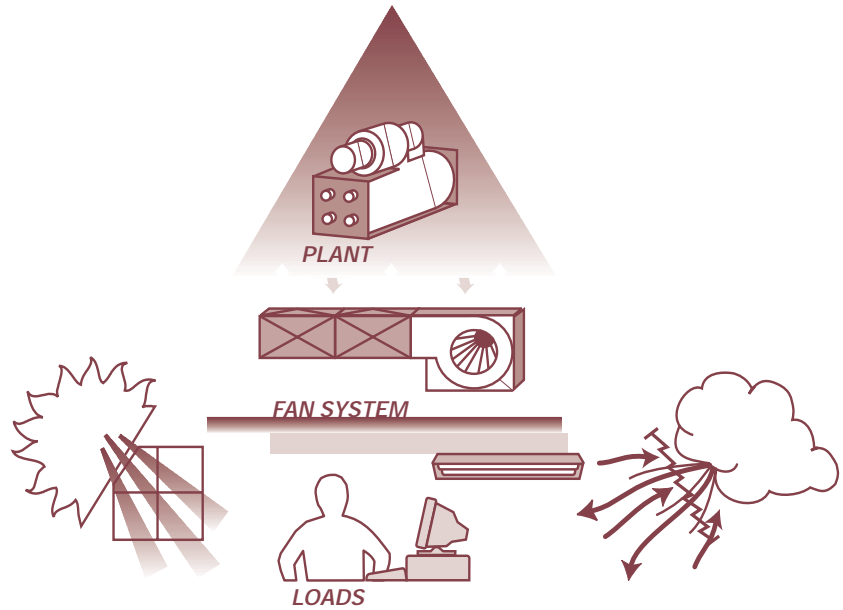
## Overview

Recommissioning is essentially the same process as commissioning, but applied to existing building's HVAC, controls, and electrical systems. When standardized maintenance and energy management procedures fail to fix chronic building problems, recommissioning provides a systematic approach for discovering and solving them. Recommissioning entails the examination of actual building equipment systems operation and maintenance procedures for comparison to intended or design operation and maintenance procedures.

The heat flow diagram (Figure 1) illustrates the interaction of all buildings systems and activities. Recommissioning capitalizes on heating, cooling, and electrical load reductions by continually monitoring energy consumption to optimize energy performance and savings. Recommissioning can be a cost-effective retrofit in itself, sometimes generating more savings than the cost of the retrofit measure. This can result in additional savings other than direct energy cost reductions. For example, a recommissioning may help avoid the need to install new or additional equipment, resulting in capital savings. In the recommissioning phase, you will continue to implement numerous cost-effective strategies to reduce your heating, cooling, and electrical loads, and your overall energy consumption, while improving occupant comfort.

Previously referred to as Building Tune-Up, the recommissioning chapter will help you understand if the building is operating as intended and if current operational needs are being met. It will help you identify improper equipment performance, opportunities for saving energy and money, and strategies for improving performance of the various building systems. "Best Ways to Save" and "Take Action" are checklists of typical opportunities to tune-up equipment and how to approach funding recommissioning.

Figure 1: Heat Flow In Buildings



#### Heat Flow In Buildings: Building Systems Interactions

Figure 2 shows the interaction of heating, cooling, and electrical loads with the HVAC equipment. Arrows indicate heat flow pathways. Reducing heating, cooling, and electrical loads reduces the demand on HVAC equipment, thus saving energy.

#### The Best Ways To Save

- Calibrate building controls such as thermostats and occupancy sensors.
- Adjust operating schedules to ensure equipment is on only when necessary.
- Check for leaking or improperly functioning steam traps.
- Clean heat exchanger tubes in the condenser, evaporator, and boiler to maintain optimal efficiency.

#### Take Action!

- Recognize building tune-up as an opportunity to reduce energy costs and regain or improve comfort.
- Allocate time and funding to a building tune-up separately from your ongoing maintenance budget.
- Explore available financing options if in-house funds are not available.



## Understanding Recommissioning Process

Making low-cost or no-cost adjustments to your building systems will not only minimize your current operating costs but will also lower future maintenance costs. Furthermore, performing a recommissioning will help you understand your building's current operational needs, how it is intended to operate, and how you can improve the current level of performance in the other stages.

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### Commissioning

*Commissioning* is a quality assurance process that ensures design intent and operational needs are met for new buildings or major rehabilitation. Ideally, commissioning takes place during the construction process and continues through occupancy.

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### Maintenance

*Maintenance* is an ongoing process to ensure that equipment operates at peak performance. It should take place following the initial system tune-up and should be routinely scheduled for the life of the equipment.

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Unlike the other four stages of an integrated upgrade approach recommissioning does not necessarily require purchasing and installing new equipment or technology. However, both time and budget should be set aside expressly for a building recommissioning. Savings, though often surprising, can be harder to estimate in advance; yet, because recommissioning plays an integral role in the process of identifying potential upgrade opportunities to be implemented in the other stages, it should be viewed, planned, and funded as a process separate from standard maintenance.

Financing can be a limiting factor, especially if a recommissioning is mistakenly lumped into the maintenance budget. Financing options are often available. See *Financing Your Energy-Efficient Upgrade* chapter.

## Performing a Successful Recommissioning Project

The key to a successful recommissioning process is the commitment of the commissioning team. The commitment may be express through a written contract defining the responsibilities and contractual relationship of team members, and the specific tasks to be performed by each team member according to area of expertise. One major task in the process is for the owner's design professionals and contractors to set realistic contract agreements and assign appropriate responsibilities. Communication among the recommissioning team and facility staff is paramount for uncovering building systems problems and opportunities.



A successful recommissioning effort also depends not only on a deep understanding of building systems but also a firm grasp on how people interact to operate the building systems from day to day. This helps the recommissioning team to collect accurate data and propose cost-effective and energy savings solutions.

Recommissioning may be performed by in-house staff or by outside contractors. A decision to obtain outside expertise should not be viewed as “pointing the finger” at maintenance staff for previous oversights but instead as an opportunity to get a non-bias assessment of building systems operation and maintenance procedures.

Facility staff that are trying to fix these problems work under a variety of constraints, including limited labor force, limited budgets, and limited access to monitoring equipment. Sometimes, facility management lack technical expertise or staff to perform diagnostic tests and repair problems.

However, recommissioning will affect the building’s future maintenance and operations program, facility staff should be updated on revised maintenance and operations procedures. In addition, facility staff should undergo regular training to learn how to effectively operate and maintain building’s systems.

## Recommissioning Strategy and Savings Potential

The strategy for recommissioning is a series of building recommissioning that build upon one another in a staged approach. By following the order suggested below, you can capitalize on the benefits of a comprehensive systems upgrade approach.

When recommissioning your building, you should keep in mind the primary goal, does the building operate as intended and are operational needs being met. For example, occupant comfort is paramount in the operational needs assessment. Occupants *will* modify their personal space to achieve comfort. This often results in tampering with thermostats and sensor calibrations, using inefficient portable lighting or space heaters, or even blocking vents, all of which will further increase energy use.



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## Potential Savings

### Building Recommissioning Offer Surprising Paybacks

A detailed assessment of the costs and benefits of tuning up buildings was conducted based on a survey of results from more than 40 tune-up projects. Results from the study confirmed that recommissioning can typically translate into energy savings of 5 to 15 percent. Although it is difficult to pinpoint exactly which tune-up procedures generate the greatest savings, a study performed by the Energy Systems Laboratory of Texas A&M University showed that about 80 percent of all savings from recommissioning come from optimizing building control systems. Improving operations and maintenance accounts for nearly all remaining savings.

Financing the tune-up of a building may require spending funds up front, although parts are generally inexpensive and expenses are minimal. However, you should plan on incurring additional labor costs. If your building's maintenance staff does not have the skills to perform tune-up procedures, or, if your staff is simply too busy, look into outside consultants such as energy service companies or utility companies. Energy service companies have offered tune-up services for years as part of shared-savings contracts. Some utilities continue to conduct recommissioning on a fee-for-service basis.

Source: "Commissioning Existing Buildings," E SOURCE Tech Update (TU-97-3; March 1997).

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Recommissioning will assist you with systematically assessing building performance and effects of occupants and equipment loads on performance. The recommissioning process consist of a series of strategically ordered building recommissioning should be implemented in the following order:

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### Building Tune-Up Strategy

- Lighting + Supplemental Loads
  - Building Envelope
  - Controls
  - Testing, Adjusting, and Balancing
  - Heat Exchange Equipment
  - Heating and Cooling System
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### ***Lighting***

The lighting systems within a building are an integral part of a comfortable working environment. Over the course of its life, all lighting systems become gradually less efficient. Certain efficiency losses are unavoidable, such as reduction in light output are due to the aging of lighting equipment. However, other efficiency losses, such as improperly functioning controls, or dirt accumulation on fixture lenses and housings and lamp lumen depreciation can be avoided by regularly scheduled lighting maintenance.

Insufficient lighting can have a negative impact on energy performance of the building. Without adequate lighting, occupants will bring in less efficient fixtures, thus increasing the lighting and cooling loads in the building.





### *Lighting Tune-Up*

A lighting system tune-up should be performed in the following order:

1. Follow a strategic lighting maintenance plan of scheduled group relamping and fixture cleaning.
2. Measure and ensure proper light levels.
3. Calibrate lighting controls.

(see Lighting chapter for lighting system specifications and details)

Periodically cleaning the existing fixtures and replacing burned-out lamps and ballasts can considerably increase fixture light output. This simple and cost-effective tune-up item can restore light levels in a building close to their initial design specifications.

After the fixtures have been cleaned and group relamping has taken place, the next step is to measure existing light levels to ensure that proper illuminance levels are provided for the tasks being performed in the space. As space use and furnishings may change over time, it is important to match the lighting level to the current occupant requirements. The Illuminating Engineering Society of North America issues recommended illuminance levels depending on the job or activity performed. Overlighted or underlighted areas should be corrected. Lighting uniformity should also be assessed, as relocation of furniture and even walls may have altered lighting distribution.

Once the proper light levels and uniformity have been achieved in the space, examine the automatic lighting controls. Many buildings use a variety of automatic controls for time-based, occupancy-based, and lighting level-based strategies. These controls may have never been properly calibrated during installation or may have been subsequently tampered with by occupants. Adjusting these controls and associated sensors now will reduce occupant complaints, maintain safety, and ensure maximum energy savings.

Many buildings utilize energy management systems, time clocks, and electronic wallbox timers to control lighting automatically based on a predictable time schedule. These systems need to be programmed correctly to ensure that lights are only operating when the building is occupied, and that overrides are operational where required. Exterior lighting schedules must also be changed throughout the year according to the season.

The performance of occupancy or motion sensors depends on customizing the sensitivity and time-delay settings to the requirements of each individual space. The sensor's installed position should also be checked to ensure adequate coverage of the occupied area. Also, keep all furnishings from obstructing the sensor's line of sight. A sample commissioning protocol is available to guide your staff or contractor to commission occupancy sensors properly (call the ENERGY STAR hotline at 1-888-STAR YES for more information).





Any indoor and outdoor photocells should also be checked at this time to ensure the desired daylight dimming or daylight switching response. Set-points should be adjusted so that the desired light levels are maintained. Photocells and dimming ballasts are also used to save energy in non-daylight areas through lumen maintenance control, a strategy to adjust system output to compensate for aging lamps and dirt accumulation on luminaries. To maintain continued energy savings in lumen maintenance control strategies, you will need to tune the set-point manually to reduce the light level by 25 to 30 percent (the expected light level depreciation over the maintenance cycle) each time fixtures are periodically cleaned and re-lamped. This will allow the ballast to increase the system output over time to maintain the illuminance set-point.

### *Savings*

Although the savings associated with performing a lighting tune-up will vary depending on the quality and performance of the current lighting system, they can be significant. For example, cleaning alone may boost fixture light output from 10 percent in enclosed fixtures in clean environments to more than 60 percent in open fixtures located in dirty areas. Simple calibration of occupancy sensors and photocells can restore correct operation, reducing the energy used by the lighting system in those areas by 50 percent or more.

### *Considerations*

- Is a scheduled lighting maintenance policy in place?
- Are spaces provided with the proper light levels?
- Have all automatic controls been calibrated?

### *Supplemental Loads*

The area of supplemental loads is also an opportunity for recommissioning. In the business world, office equipment constitutes the fastest growing portion of electrical loads. However, much of this energy is wasted because equipment is left on when not in use throughout the workday, at night, and on weekends. Electrical loads from office equipment can be reduced by the use of ENERGY STAR labeled office equipment and/or enabling power management features.

### *Supplemental Loads Tune-up*

For existing office equipment models, check to see if they have power management or other energy-saving features and that these features are enabled. Whether or not they may not meet the ENERGY STAR specifications, these features will provide some energy savings if activated.



Educate employees so that they understand what power management is and why it is important. Here are some examples of issues that you should focus on:

- Sleeping equipment still draws some electricity; so turn it off when not in use for long periods of time.
- Heat is a leading cause of equipment failure. When the power-management feature is used, the computer generates less heat, so it may last longer and have improved reliability.
- If screen savers are used in the office, be sure to choose those that will display images for a predetermined period of time and then enter the sleep mode. Graphical screen savers are primarily for entertainment and are not energy-efficient features.

### *Savings*

Energy-efficient equipment with the ENERGY STAR label cost the same as comparable non-labeled equipment. However, the savings are greater for labeled equipment. Products that meet ENERGY STAR specifications use about half as much electricity as conventional equipment. ENERGY STAR labeled and non-labeled equipment produce less heat when powered down or not in use, which results in reduced cooling loads, and energy costs.

### *Considerations*

- Is your organization purchasing office equipment with the ENERGY STAR label?
- Are energy saving features enabled on office equipment?

### ***Building Envelope***

The next step of a building tune-up is to reduce air infiltration through the building envelope to enhance occupant comfort. Outside air can penetrate a building through a variety of places, most commonly through the windows, doors, walls, and roof. Drafts created by improperly sealed windows and doors can cause cold hands and feet in the winter and discomfort in the summer.

In general, a building envelope should meet recommended infiltration standards. For commercial buildings, the National Association of Architectural Metal Manufacturers recommends infiltration rates per unit of exterior wall not to exceed 0.06 cubic feet per minute per square foot (cfm/sf) at a pressure difference of 0.3 in. of water (ASHRAE *Fundamentals Handbook*, 2001, 26.24).

A frequent result of infiltration problems, other than general occupant complaints, is an increase in building heating, cooling, and/or electrical loads (when, for example, occupants bring in space heaters or fans). In addition, the escape of conditioned air forces the air handling system to work longer and harder to provide the required





space temperature. Thus, tuning up the envelope of a building can reduce HVAC costs while greatly improving occupant comfort.

### *Tune-Up*

The first step in reducing air infiltration is to tighten the existing building by locating all air leaks in the windows, doors, walls, and roofs. Once you have detected the air leaks, seal them with appropriate materials and techniques such as weather-stripping on doors, sealing and caulking on windows, and proper insulation distribution in walls, ceilings, and roofing.

If your building is equipped with revolving doors, you should encourage their use. Revolving doors significantly reduce drafts and conditioned air loss. Automatic doors should be calibrated to minimize air loss from the building envelope.

### *Savings*

Reducing infiltration will result in a reduction in heating and cooling loads. Savings will depend on many factors, including the existing condition of the building; the building surface area-to-volume ratio; construction type; geographical location; and the internal heating, cooling, and electrical loads. Typical savings for a large office building range up to 5 percent of heating and cooling costs.

### *Considerations*

- Are any areas particularly drafty?
- Are any areas routinely serviced?
- Do the windows and doors close and seal properly?
- Are the windows and door frames adequately caulked?
- Is weather stripping installed on windows and doorways?
- Is there any wet or deteriorating insulation that needs to be replaced?

### *Controls*

The energy management system and controls within a building play a crucial role in providing a comfortable building environment. Over time, temperature sensors or thermostats often become out of tune. Wall thermostats are frequently adjusted by occupants, throwing off controls and causing unintended energy consumption within a building.

Poorly calibrated sensors cause increased heating and cooling loads and occupant discomfort. As with envelope infiltration problems, occupants are likely to take matters into their own hands if they are consistently experiencing heating or cooling problems. By integrating mechanical and control recommissioning within each system, you are more likely to improve occupant comfort.



### *Tune-Up*

The first step in tuning up controls is to calibrate the indoor and outdoor building sensors. Calibration of room thermostats, duct thermostats, humidistats, and pressure and temperature sensors should be in accordance with the original design specifications. Calibrating these controls may require specialized skills or equipment, such as computer software. Thus, you should seriously consider the use of outside expertise for this tune-up item.

In addition to calibrating the sensors, damper and valve controls should be inspected to make sure they are functioning properly. Check pneumatically controlled dampers for leaks in the compressed air hose lines. Also examine dampers to ensure they open and close properly. Stiff dampers can cause improper modulation of the amount of outside air being used in the supply air stream. In some cases, dampers may have actually be wired in a single position or disconnected entirely, violating minimum outside air requirements (for a more detailed explanation, see Supplemental Load Reductions).

As part of tuning up controls, be sure to review building operating schedules. Often, while control schedules remain constant, occupancy schedules change frequently over the life of a building. This results in discomfort at the beginning and end of each day. HVAC controls must be adjusted to heat and cool the building properly during occupied hours. For example, operating schedules should be adjusted to reflect Daylight Savings Time.

When the building is unoccupied, set the temperature back to save some heating or cooling energy. Keep in mind that some minimum heating and cooling may be required when the building is unoccupied. In cold climates, for example, heating may be needed to keep water pipes from freezing.

In addition to the building's operation schedule, review the utility rate schedule. Utilities typically charge on-peak and off-peak times within a rate, which can dramatically affect the amount of your electric bills. If possible, equipment should run during the less expensive off-peak hours. For certain buildings, precooling and/or preheating strategies may be called for. (See also Supplemental Load Reductions, Night Precooling, p. 14.)

### *Savings*

The main savings associated with tuning controls result from reductions in charges for heating and cooling energy (and possibly demand). Because savings are heavily dependent on the existing condition of the controls, it is difficult to estimate the actual savings that will result from a tune-up. Savings will depend on many factors related to the building including heating and cooling system types; construction; geographical location; and internal heating, cooling, and electrical loads. Typical savings can range up to 30 percent of annual heating and cooling costs.



### *Considerations*

- Are building sensors, such as thermostats and humidistats, calibrated and operating properly?
- Are damper and valve controls functioning properly?
- Are there any leaks present in the pneumatic control systems?
- Do equipment schedules reflect occupancy schedules and seasonal changes?
- Can certain equipment be scheduled to operate during utility off-peak hours?
- Can temperatures be set-back during unoccupied times?

### ***Testing, Adjusting, And Balancing***

Proper air and water distribution in an HVAC system is critical to create comfortable conditions within a given space. Excessive room air temperature fluctuations, excessive draft, and improper air distributions will lead to occupants' discomfort and can increase energy consumption.

Testing, adjusting, and balancing (TAB) involves investigating the current state of a system and making adjustments to bring the HVAC system back into balance and close to its original design specifications. As we mentioned before, over time, occupancy levels and space utilization may change dramatically. The TAB process will help identify and make necessary adjustments to fit these changes, thereby improving occupant comfort and saving energy costs.

A qualified TAB contractor should:

- Verify the current state of the system.
- Identify and correct any problems with the system.
- Ensure the system provides proper indoor air quality.

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#### Testing, Adjusting, And Balancing

*Testing, Adjusting, and Balancing* (TAB) is the process of adjusting HVAC system components to supply air and water flows to match load requirements.

TAB generally includes:

*Testing:* The process of evaluating the performance of the equipment in its current state and making recommendations for improvements.

*Adjusting:* The process of regulating flow rates of air or water for the purpose of balancing the system.

*Balancing:* The process of proportioning the air or water flows throughout a building to match the loads.

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Perform TAB analysis on a building whenever you think that the air or water distribution system is not functioning as designed. Indicators that TAB is needed include frequent complaints from occupants about hot or cold spots in a building, the



renovation of spaces for different uses and occupancy, and the frequent adjustment of HVAC components to maintain comfort.

### *Tune-Up*

A TAB analysis usually includes a complete review of a building's design documentation. Typical HVAC system components and parameters to investigate may include:

- Air system flow rates, including supply, return, exhaust, and outside airflow. Flows include main ducts, branches, and supply diffusers that lead to specific spaces in a building.
- Water system flow rates for chillers, condensers, boilers, and primary and/or secondary heating and cooling coils.
- Temperatures of heating and cooling delivery systems (air side and water side).
- Positions and functioning of flow control devices for air and water delivery systems.
- Control settings and operation.
- Fan and pump speeds and pressures.

The TAB contractor will provide a test and balance report with a complete record of the design specifications, preliminary measurements, and final test data. All discrepancies between the design and test data should be outlined along with an analysis. The report should also include recommended and completed adjustments.

### *Savings*

The savings associated with TAB come from the reductions in the energy used by the heating and cooling system. Because savings are heavily dependent on the building's condition, it is difficult to estimate the actual savings that will result from TAB. Savings will differ depending on many factors related to the building including heating and cooling system types, construction, geographical location, and internal heating, cooling, and electrical loads. Savings can range up to 10 percent of heating and cooling costs.

### *Considerations*

- Are occupants frequently complaining about the temperature, humidity, etc., in the building?
- Have HVAC system components been replaced or modified?
- Has any building space been renovated?
- Can the HVAC system satisfy comfort requirements during very hot or very cold days?





### *Heat Exchange Equipment*

The next steps in building tune-up focus on the heat exchange equipment that cools and heats the air that ultimately reaches building spaces. This equipment usually consists of heating and cooling coils installed in air handlers, fan coil terminal units, or baseboard radiators. These units are typically supplied with chilled water and hot water from a central plant. The heating and cooling coils can also be part of a packaged unit such as a rooftop air conditioning unit or central station air handling unit.

As with other tune-up items, tuning up your heat exchange equipment has the potential not only to save energy costs but also to increase your building occupants' comfort.

Although many of the tune-up recommendations presented below should be performed as normally scheduled maintenance, they are included in Supplemental Load Reductions because of the potential for resultant energy cost savings.

The controls and flow issues for heat exchange equipment were addressed in the previous controls and TAB sections. The remaining action is to ensure that all surfaces and filters are clean. Dirty surfaces reduce heat transfer, increase pressure loss, and increase energy use.

#### *Tune-Up*

Clean the air side of heating and cooling coils, whether in an air handler or in a rooftop unit, to reduce deposit buildup. Methods for cleaning may include compressed air, dust rags/brushes, and power washes. Check baseboard heating systems for dust build up and clean if necessary.

The water side of heating and cooling systems is generally inaccessible for mechanical cleaning. Chemical treatments are often the best solution to clean these surfaces. Ongoing water treatment and filtering of the water side is recommended to reduce dirt, biological, and mineral scale buildup. Filters for both air side and water side systems should be cleaned and replaced as necessary.

Avoid covering or blocking terminal fan coil units and baseboards with books, boxes, or file cabinets. Besides creating a fire hazard (in the case of radiators), blocking the units prevents proper air circulation and renders heating and cooling inefficient.

#### *Savings*

The savings you will see from a tune-up of your heat exchange equipment are highly dependent upon the existing conditions of the equipment. In general, the more you can improve the heat transfer of surfaces, the more you will save. Additionally, cleaning coils and filters may reduce the pressure drop across the coil and reduce fan or pump energy consumption.





Savings will differ depending on many factors related to the building, including heating and cooling system types; construction; geographical location; and internal heating, cooling, and electrical loads. Typical heating and cooling system cost savings can range up to 10 percent.

#### *Considerations*

- Are the heating and cooling surfaces clean?
- Are air and water filters changed regularly?
- Are heating or cooling terminal units and baseboards blocked by furniture or debris?

#### ***Heating and Cooling System***

Following the framework of the integrated approach, the final step is to tune up the heating and cooling system. The heating and cooling system, generally a central plant, supplies all of the heating and cooling to make building spaces comfortable. Some buildings may have distributed heating and cooling units or a combination of both instead of a designated central plant.

The information gathered during the previous sections may become useful in determining any potential operational changes to the central plant. Additionally, recommissioning conducted on the HVAC and lighting systems should reduce the amount of energy the central plant consumes.

Some of the following tune-up items should be performed as part of normal scheduled maintenance. They are included here because of their potential for resultant energy cost savings. Specially trained and qualified personnel should perform all of these tune-up procedures.

#### *Chiller Tune-Up*

Chillers are similar to air conditioners found in any home, except that chillers supply cool water and home air conditioners supply cool air. The cool water from a chiller is eventually pumped through a heat exchanger (i.e., cooling coil), which cools the building's air. (For more information on specific types of chiller equipment, see Heating And Cooling System Upgrades.)

**Chilled Water And Condenser Water Temperature Reset** – A chiller's operating efficiency can be increased by raising the chilled water temperature and/or by decreasing the temperature of the condenser water. Chilled water reset is the practice of modifying the chilled water temperature and/or condenser water temperature in order to reduce chiller energy consumption.

If you decide to undertake chilled water reset, be careful that all of the considerations are taken into account. Although raising the chilled water will reduce



chiller energy consumption, it may increase supply fan energy consumption. Reducing the condenser water temperature may increase the cooling tower fan energy consumption as well. Be sure to consult experts who can analyze all the effects of chilled water reset. If in doubt, using the intended design temperatures is your safest bet (E SOURCE, *Space Cooling Atlas*).

**Chiller Tube Cleaning And Water Treatment** – Optimum heat transfer relies on clean surfaces on both the refrigerant and water side of the chiller tubes. Typically, the water side of the condenser needs the most attention because evaporative cooling towers have an open loop and new water is introduced continuously. Thus, water treatment is needed to keep surfaces clean and reduce biological films and mineral scale. Similar treatments may be needed for the chilled water loop.

As part of the tune-up, clean the condenser and evaporator tubes to remove any scale or buildup of biological film. To do this, the surfaces usually have to be physically scrubbed and sometimes treated with chemicals.

**Reciprocating Compressor Unloading** – Reciprocating compressors are typically used for smaller chillers. Many of these compressors utilize multiple stages (that is, more than one piston for the compressor) of cooling to allow for more efficient part-load performance and reduced cycling of the compressor motor.

At part-load performance, one or more of the stages are unloaded. If the controls of the system fail to unload the cooling stage, then the system may cycle unnecessarily during low cooling loads. Because starting and stopping is inherently inefficient, cycling decreases the efficiency of the cooling system. Additionally, increased cycling can lead to compressor and/or electrical failures (E SOURCE, *Space Cooling Atlas*).

Consult manufacturer's maintenance information to check for proper cooling stage unloading. Unloading may be controlled by a pressure sensor that is set for a specific evaporator pressure. This sensor, and the controls dependent upon it, can fall out of calibration or fail.

### *Boiler Tune-Up*

In many buildings, the boiler is the heart of the heating system. Steam or hot-water boilers are present in approximately 42 percent of heated commercial floor space (CBECS, 1995).

When considering a tune-up for a boiler, always make sure that you and the maintenance staff or contractor know and fully understand all safety precautions. Also, always follow manufacturer's information on maintenance and local safety or environmental codes. ENERGY STAR recommends you consider obtaining specialized expertise for boiler tune-up items.



**Boiler System Steam Traps** – Steam heating systems use mechanical devices called steam traps to remove condensate and air from the system. Steam traps frequently become stuck in the open or closed position. When a trap is stuck open, steam can escape through the condensate return lines to the atmosphere, and the resulting energy loss can be significant. Check steam traps for leaks frequently and make repairs as needed. Because special tools and experience are required, you should consider the use of outside expertise.

**Combustion Air** – More air is typically supplied for combustion than is needed. Excess air helps prevent incomplete combustion, which contributes to associated hazards such as smoke and carbon monoxide buildup. If too much air is introduced, some of the fuel is wasted heating this excess air. A tune-up of combustion air consists of adjusting combustion air intake until measured oxygen levels in the flue gas reach a safe minimum. (This tune-up measure does not apply to electric boilers.)

**Boiler Tube Cleaning And Water Treatment** – Optimum heat transfer relies on clean surfaces on both the boiler's combustion and water or steam side. Surfaces that are dirtied with fouling (see sidebar) will ultimately increase the energy consumption of the heating system. A tune-up consists of removing fouling buildup from both the fire side and water side of the boiler tubes by physically scrubbing the surfaces and sometimes by applying a chemical treatment.

Additionally, treating the heating water may be a good option to reduce the further deterioration of your boiler tubes.

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#### Fouling

Fouling is the buildup of a film that reduces heat transfer. Soot, ash, or other particles can build up on the fire side surfaces of a boiler. Mineral deposits or other materials can build up on the water or steam side surfaces.

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#### *Heating and Cooling Equipment Savings*

The savings associated with central plant recommissioning are derived from reducing the energy consumption of the heating and cooling system. Savings are highly dependent on the existing condition of the equipment. Other related factors include the heating and cooling system types; construction type; geographical location; and internal heating, cooling, and electrical loads.

Savings for most of the central plant recommissioning are listed below. When all recommissioning are taken together, heating and cooling cost savings can reach upwards of 15 percent.

**Chilled Water and Condenser Water Temperature Reset** – The savings associated with a water temperature reset will vary, depending on equipment type and system interactions. Because temperature reset does not require the purchase of new



equipment, it can often be inexpensive. The complexity of reset, however, could result in incorrect implementation, instead increasing your energy use. Therefore, a professional consultant should be contacted who will be able to estimate the savings potential.

**Chiller Tube Cleaning and Water Treatment** – The savings achieved by cleaning tube surfaces are highly dependent on the current state of the tubes. Savings can be estimated by looking at what the temperature change through the evaporator or condenser should be and comparing it to the actual temperature change. Contact an HVAC consultant or a chiller specialist for a savings estimate.

**Boiler System Steam Traps** – The savings achieved by fixing steam trap leaks is highly dependent on the size of the leak and the pressure of the system. Table 1 compares orifice size with the estimated steam leaked per month and the resulting costs.

Table 1: Steam Trap Leaks

<i>Size of Orifice (in.)</i>	<i>Steam Leak per month (lb.)</i>	<i>Total Cost per month (\$)</i>
1/2	835,000	2,480
7/16	637,000	1,892
3/8	470,000	1,396

Based on: 100 psi, boiler efficiency of 80 percent, energy cost of \$2 per million Btu.

Source: Wayne C. Turner. *Energy Management Handbook*, 2nd ed., 1993, Fairmont Press, Table 14.17, page 341.

**Boiler Combustion Air** – The savings for the reduction of combustion air depend on the type of fuel used and the exiting flue gas temperature. Stage Five—Heating and Cooling System Upgrades includes a detailed plot of boiler fuel savings as excess air is adjusted. For example, for every 10 percent reduction in excess air, the boiler efficiency will increase 0.7 percent (based on burning No. 2 fuel oil with a flue gas temperature of 500° F).

**Boiler Tube Cleaning and Water Treatment** – The savings achieved by cleaning the tube surfaces is highly dependent on the current state of the tubes. Tables 2 and 3 illustrate the increased fuel consumption that results from surface fouling on the combustion and water side of a boiler.



Table 2: Boiler Combustion Fouling

Soot layer on heating surface (in.)	Increase in fuel consumption (%)
1/32	2.5
1/16	4.4
1/8	8.5

Source: W.H. Axtman, *Boiler Fuel Management and Energy Conservation*, American Boiler Manufacturers Association.

Table 3: Boiler Water Side Fouling

Thickness of scale (soft carbonate scale) (in.)	Increase in fuel consumption (%)
1/32	7.0
1/16	12.5
1/11	15.0

Source: W.H. Axtman, *Boiler Fuel Management and Energy Conservation*, American Boiler Manufacturers Association.

## Considerations

### Chillers

- Have you consulted an expert to determine the implications of chilled water temperature reset on supply fan energy consumption?
- How dirty are your evaporator and condenser tubes?
- Are reciprocating compressor cylinders unloading at part load?

### Boilers

- Have the steam traps been inspected for leaks?
- Has combustion air been checked in the last year?
- Have the combustion and water or steam side heat transfer surfaces been cleaned recently?

## Summary

To recap, your strategy for recommissioning should follow the framework an integrated staged approach. Keep in mind that the overriding concern in performing recommissioning is to ensure that the building operates as intended and meets current operational needs.





Building tune-up strategies should be implemented in the following order:

- Lighting + Supplemental Loads
- Building Envelope
- Controls
- Testing, Adjusting, And Balancing
- Heat Exchange Equipment
- Heating And Cooling System

#### ***Next Steps***

- Make certain that facility staff receive training so that they are familiar with tuning and maintaining building systems.
- Use the information learned in recommissioning to identify and implement other energy performance strategies and savings opportunities in throughout the entire building and its systems.